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AUTHOR Heathers, Glen
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ABSTRACT

Educational technology presents a challenge to educators. It makes possible the instruction of an individual in any course the educator deems necessary. In order to utilize these new opportunities effectively, the educators must decide what the goals are for a person in an automated society. The educator must deal less with the teaching of information and shift to teaching ideas, methods of inquiry, independent learning, personal development, and social living. He must contend with the special problems of poor children, the need for excellence, and the demand for individualized instruction. Educational technology has the potential to participate in the dissemination of these educational values and to solve these educational problems. To accomplish this there must be more effective and better coordinated application of scientific technological methods. There must be research on educational values; there must be application of this research in the design of instructional programs and in the education of educators. It will also be necessary to provide information about the technological revolution in education to the general public. (JY)

EDUCATIONAL PHILOSOPHY AND EDUCATIONAL TECHNOLOGY

by Glen Heathers*

Educational philosophy is concerned mainly with the values education has, could have, or ought to have, for individuals and for society. Educational technology is concerned chiefly with the rational means whereby valued educational outcomes are, or could be, achieved. Viewed this simply, philosophy and technology have an essential relationship; the former specifies the goals education can strive toward while the latter provides means for reaching them. In practice, this statement of relationship is over-simple. Technology (in the form of research methodologies) can be useful in selecting educational values and even in evaluating values through searching out their interrelationships. Also, educational technology can determine in part the values toward which education is directed through making possible the accomplishment of certain goals. As Broudy states it, " ... scientifically based technology is the most dynamic single factor in determining the scope of our possible duty ... because it changes the domain of what we can do, out of which emerges the domain of what we ought to do."[1] He holds that "the abatement of ignorance" is our obligation today since we now have the power to accomplish it. A final sort

* Glen Heathers is Professor of Educational Research at the Learning Research and Development Center, University of Pittsburgh.

of relationship between philosophy and technology in education is that they can proceed independently. This very often is the case, technology being put to use without examining even the potential it holds for realizing designated educational outcomes.

Most educators identify "the new educational technology" with machines and machine-linked learning programs. Many spokesmen on education distrust bringing machines into the schools, believing that their greatest effects will be to dehumanize instruction in the interest of efficiency. They hold this belief despite daily evidences that technological developments bear no fixed relationships to valued outcomes and that it is the uses made of technologies that determine their value relevancies. A laser beam can become a death ray or a surgical tool. Television can be used to advertise cigarettes and extol violence or to fight pollution and model racial tolerance. It is not machines that merit distrust, but the people who use machines, whether in the schools or elsewhere. A worthy aim is for educators to learn to use instructional machines to good purpose, and to teach their students to control and exploit machines in ways that benefit them and their fellows.

The most fundamental components of "the new educational technology" do not have to do with machines. Rather, they involve applications of basic scientific-technological methodologies to education. It is the impact of these methodologies, assisted by electronic computers, that seems certain to revolutionize education. These methods have developed largely outside education. Presently they are being put to use in devising,

producing, and evaluating educational innovations. The methodologies we refer to include scientific methods of inquiry; research-and-development strategies and procedures; systems approaches; operations research; training research; cost/efficiency accounting; and policy research. It is significant that these powerful intellectual tools are being adapted for use in education mainly by persons trained in the behavioral or social sciences, rather than by professional educators. For example, the important volume, Training Research and Education, was edited by a psychologist, Robert Glaser, and nearly all of its chapter authors received their training and experience outside the field of education.[2]

Scientific-technological methods, as employed within education, promise to transform virtually every aspect of instruction. We can look to policy research for powerful analyses of educational aims as they relate to the nature and purposes of individuals and society. We can expect from behavioral and social science the development of a theory of instruction based on research in individual development involving learning, perceiving, thinking, feeling, motivation, personality, and social behavior. Research-and-development strategies, systems approaches, and training research can provide instructional programs, materials, equipment, and staff that implement a research-derived theory of instruction and guide students toward goals that have been identified and justified by educational philosophers, policy researchers, and others.

Scientific-Technological Society: A Challenge to Educators

Interpreters and evaluators of today's society are in general agreement on its salient features and their probable projections into the future. The slogan terms all are familiar: mass production, mass communications, automation, efficiency, impersonality, bureaucracy, complexity, rapid change, and unpredictability. The dynamic basis for creating this society has been the systematic and pervasive use of scientific rationalism. James E. Russell summarizes the process in these words: "There is a change in the role of the mind in human affairs, in the role of the rational ... The processes involved are those of rational inquiry and empirical validation, the harnessing through logic and evidence of the abilities to recall and imagine, to classify and generalize, to evaluate and compare, to analyze and synthesize, to deduce and infer."[3]

Archibald MacLeish finds the essential value commitment of scientific society in the initial application of nuclear power. "After Hiroshima it was obvious that the loyalty of science was not to humanity but to truth --its own truth--and that the law of science was not the law of the good--what humanity thinks of as good, meaning moral, decent, human--but the law of the possible."[4]

C. Wright Mills is equally dubious about the human implications of science and technology. "Science, it turns out, is not a technological Second Coming. That its techniques and its rationality are given a central place in a society does not mean that men live reasonably and without myth, fraud, and superstition ... The mass distribution of historic culture may

not lift the level of cultural sensibility, but rather merely banalize it--and compete mightily with the chance for creative innovation. A high level of bureaucratic rationality and of technology does not mean a high level of either individual or social intelligence."[5]

I. A. Richards identifies the computer as the greatest force for good or evil in technology's armamentarium. "All the foregoing epochal steps may be regarded as extensions of familiar specific capabilities; steam replaced and transcended men's and horses' muscular energy as photography and telephony surpassed and extended the range of our distance receptors. So, more widely, did radio and television. But the offerings of the computer go beyond all such services; they extend the resources of the central nervous system itself. The computer can supply an inexhaustible slave service for whatever we have the wits to instruct it to do. Suddenly, we have a Caliban-Ariel executive that will achieve for us all that we, in our wisdom or folly, can contrive to tell it how to handle."

Richards further points the moral: "Someone will reply that computers by taking immense intellectual burdens off our shoulders, will free us for precisely these tasks of ultimate choice, these legislative acts. We may hope so, while fearing that they will not. Almost all of us are products of the assistance we can accept. Equally, we are potential victims of those who, for whatever motives, would like to run things for us. Like all power sources, the computer is not going to lessen our responsibilities but to increase them."[6]

The massive and rapid changes in knowledge, technologies, and social forms that characterize society today have vital implications for the individual as a worker, citizen, and person. With respect to vocational requirements, the point made by nearly every commentator is the paradoxical one that increasing automation tends to eliminate routine jobs and to retain or create jobs requiring communication skills, planning ability, and problem-solving competencies. Further, technological advances occasion frequent changes in job requirements, placing demands on the worker to keep his knowledge of his job up-to-date or to undertake training for a new type of job. Gow and co-authors sum it up: "The premium is, therefore, not on skills per se, but on the capacity to acquire skills, to modify them, and perhaps to begin again. Adaptability and flexibility are the key qualities demanded of today's worker."[7]

Broudy is one social analyst who questions whether, in the main, automation will place higher intellectual demands on the worker. He reasons that "although it has been argued that automation will necessitate large numbers of trained personnel within the labor force, it is not inconceivable that by splitting up jobs that now require a fairly high order of formal training, the amount of such training will be so reduced that it can be learned by apprenticeship or in relatively short periods of guided practice. In any event, there seems to be no foreseeable future when a substantial proportion of our population cannot get by quite well with relatively little effort of body, mind, or will."[8]

Very likely both viewpoints---Broudy's and the more usual one--share the truth concerning automation and job requirements. In this connection, it is of interest that Prime Minister Trudeau of Canada finds political capital in a presumed relationship between changing society and changing job requirements at top governmental levels. In a recent interview, he reported himself to be future-oriented. "It's one of the arguments I used in the leadership campaign, when they said, 'You don't have experience, how can you aspire to be a Prime Minister?' My answer was, Well, in the rapidly changing world, the experience isn't always very useful. The data are so different from one year to the next that what you learned in a previous context can hamstring you."[9]

Komoski proposes that there has very recently occurred in America a "radical shift ... from a primarily goods-producing economy to the first predominantly service-rendering economy." One indication of this is what Komoski terms a change from standardization to "optionization." He notes that "technology is able to provide seemingly endless arrays of goods and services that cater to individual needs and tastes of every variety."[10] This aspect of a service-rendering economy does not directly imply any changes in job requirements since it is automation that permits the great variety of products. A more fundamental point is that, as more jobs in the production and distribution of goods become automated, an increasing proportion of workers will find themselves engaged in service occupations; Komoski notes that, among such occupations, education is the largest. The clear implication is that skills in human relations and communication will become increasingly important in our economy.

An aspect of employment in bureaucratic organizations concerns job satisfaction and morale. As Luther Evans has pointed out, automation rather precisely regulates the individual by preplanning in detail what he does on the job and what human relationships are permissible there.[11] Broudy, however, offers a safety valve to this predicament. "The very system that has reduced the individual's freedom occupationally may help to free him from it psychologically. With automation and new forms of power, earning a living may well become a peripheral rather than a central principle of life and one's key significance may not be sought there." He goes on to suggest that the critical question with a 20-hour work week is whether the worker is prepared to spend the other 20 hours as "an authentic individual."[12]

A major product of science and technology has been a revolution in agriculture that has been the chief factor in the migration of millions from rural areas into the cities. The fact that most of these migrants lack the education and training required to obtain employment in urban society has imposed severe strains on the economic, political, and social components of our society. Frank Jennings doubts that these strains can be relieved except by bringing all of our resources to bear on them. "The forces that are roiling in our cities cannot be harnessed by education alone ... It is possible that the new critical mass will blow down all the school walls and let the whole of urban society into the classroom. Perhaps the cities themselves must be re-created as giant learning centers."[13]

The effects of the scientific-technological revolution are as pervasive and powerful in the political and social aspects of society as in the economic. These areas too are characterized by mass organization, intense pressures toward conformity to group norms, rapid change, and great uncertainty. Under these circumstances, individuality tends to be stifled and choices reduced to a few group-sanctioned alternatives. Yet, if people are to retain, or regain, control of society, this must occur through the exercise of social influence and political power. Broudy has stated well what must occur if citizens are to control modern society: "The alternatives to tyranny by experts or mindless nose counting in such a society is political education for the masses. Such education requires certain kinds of knowledge, learning skills, and skills of deliberation and imagination."[14]

The impact of modern society on the individual goes beyond the changes it imposes on his economic, political, and social roles. It profoundly influences his view of his world and of himself. Alvin Toffler has sought to express the effect of cataclysmic change on the individual with the term "future shock." He writes: "We have encountered the future so rapidly and with such violent changes in the ordered and familiar patterns of our way of life that we are suffering ... the dizzying disorientation brought on by the premature arrival of the future."[15] Today's future in America is the stalemated war in Vietnam; the imminence of racial warfare; civil disobedience and police brutality; the struggle of cities for economic and social survival; inflation coupled with rapidly-rising

taxes; strikes by students, teachers, firemen, and policemen; and the ever-present monsters and bugaboos of the Cold War. In such a world, there looks to be no counter against onrushing events, and no hiding place from them. One becomes an observer of instant history and asks, not what he can or should do, but merely, "What happens next?"

Gow, Holzner, and Pendleton offer a telling analysis of the thinking man's predicament today. He must accept change as the rule while surrendering the belief that progress is the natural trend of human society. He "feels that progress, if it is to occur, has to be fashioned--and that it is, at best, precarious." "He orients himself to probabilities, not certainties, thus facing up to the fact that man is compelled to make responsible decisions in the face of uncertainty. ... He requires a high level of tolerance for uncertainty and the ability to overcome through action the anxiety arising in situations of crises; and he is often fearful lest these demands prove too much for him and his fellow-men."

These analysts see modern man as highly reflective, trying to cope with uncertainty through searching out the motives underlying his and others' actions. They find some positive features of the view man is taking of himself and his world. A "new individualism has emerged through the concern for the responsibility of society to its members and of the citizen to his state. ... This view of individualism is reflected in the movement to provide equal opportunities for all children, to overcome discrimination, and to build a new conception of the state as the protector of the individual."[16]

The most telling evidence today for individualism linked with social purpose is found in the world-wide revolt of youth against the impositions of adult society coupled with the readiness young people are showing to commit themselves to the welfare of people less fortunate than themselves. While many youths have joined the hippies, others have joined the Peace Corps, fought for civil rights for Negroes, and campaigned with Eugene McCarthy for what they and he believe to be a better world.

In sum, what challenges to educators does the automated society present? In the economic realm, there is an increasing demand for workers possessing competencies in problem solving and human relations, and for people who are ready to relearn their jobs or prepare for different jobs. Also, education must reach the millions in our Appalachias and Harlems who presently are not being equipped to hold jobs in urban, industrial society.

In the political sphere, general education is needed to equip all our citizens for responsible decision making. The alternative is the abrogation of democracy through permitting control of our society by whatever special-interest group can seize power--Fascists, technocrats, generals, unions, or corporations. Citizens in a democracy must have the autonomy and wisdom to persuade themselves while resisting the persuaders.

In the social realm, the increasing need is for the attitudes and skills required for effective interpersonal and intergroup relations. Our society is split into warring camps that are both unprepared and disinclined to find common purposes through negotiation. Ways must be found to break

through the communication barriers separating young and old, Black and White, affluent and poor. Basic education for social living is needed by children, youth, and adults equally.

In the personal sphere, education needs to foster the development of individuality that can withstand societal pressures toward becoming what Mills has labeled The Cheerful Robot. The individual needs to be able to tolerate or cope with the complexitities, contradictions, and uncertainties of mass society. He should be enabled to achieve personal satisfactions and develop meaningful human relationships despite the impersonal qualities of automation. And, since personal man provides the foundation for social man, the individual needs to learn empathy, tolerance, and the will to serve others as well as himself. The increased leisure individuals will have as a product of automation offers the opportunity, as Broudy puts it, to choose between "self-cultivation" and "distraction or boredom." Education for productive and enjoyable uses of leisure becomes a critical requirement since few people spontaneously learn such things.

Educational Aims for Today's World

Spokesmen within and outside education have brought forward a set of educational aims--or themes--that reflect their conceptions of modern society and of the education required for membership within it. These themes, on the face of them, do not bear the stamp of technology. Indeed, they appear to be a revival, a re-assertion, a rethinking of the philosophy of education presented by John Dewey. They mirror his scientific

rationalism, his pragmatism, his emphasis on learning as experiencing and reflecting on one's experiences, and his stress on education for social living. These aims focus on the development of the individual learner, emphasizing his individuality, autonomy, and competence. They speak for the free, inner-directed person whose qualities and powers express adaptability rather than adaptation, decision-making rather than passive accommodation, openness to new learnings rather than rigid, unthinking adherence to accustomed views and familiar ways. In this section, these educational aims will be listed and characterized. In the following section, they will be viewed as they relate to the new educational technology. The reader should note that, while each of the themes presented below has numerous exponents in the literature, this list of eight is the writer's own and reflects his perceptions and biases.

Theme 1: Ideas. Today's curriculum innovators are generally agreed that instruction in the schools and colleges must shift from a predominant concern with teaching information within the subject-matter disciplines to a focus on teaching a command of powerful, general ideas that provide the bases for ordering, interpreting, and predicting phenomena within the domain covered by a discipline. Schwab has labeled this orientation as that of teaching the "structure" of a discipline.[17] Learning the structure of ideas within a discipline--concepts, principles, theoretical models--is an economical and therefore practical approach, considering that the student cannot possibly "cover the facts" of any field of knowledge, and considering that facts have little use--other than in information-please programs--

except as they are employed in developing or applying ideas. This is true in regard to all students in all curricular areas. Slow learners even more than gifted students need to be taken off a factual diet since, unlike the gifted, they have very limited powers themselves to organize facts and draw ideas from them.

Theme 2: Inquiry. It is the fashion today among curriculum writers in the areas of natural science and social science to place emphasis above all on teaching the "methods of inquiry" employed by scientists and scholars in the respective disciplines. In the area of mathematics, the fashion is to speak of "learning by discovery." In the humanities and the arts, the favored term is "creativity." It is this writer's preference to use inquiry as the general term for competencies in problem solving or creative production. In this usage, inquiry covers the intellectual operations and procedures a person uses in working toward the solution of any sort of academic or practical problem. By "problem" is meant more than a difficulty to be overcome. Also, it refers to any purpose or task calling upon the individual to work out a solution.

As was true of John Dewey, many educational leaders today believe that the most important function of education is to develop the individual's capabilities in inquiry toward the purpose of enabling him to function as an autonomous problem-solver in his various life roles, or to be an effective participant in group problem-solving. Clearly, inquiry-centered education is relevant to a society where knowledge and the uses of knowledge are changing with great rapidity. (Prime Minister Trudeau might better

have claimed competencies in inquiry than professing as he did the lack of knowledge that might hamstring him.) If education is to prepare the individual adequately to confront life's problems, it must enable him to inquire about the consequences of actions and events--their values--since many decisions he makes in his roles as student, worker, citizen, community member, family member, or private person involve questions of value.

Theme 3: Independent Learning. Closely related to inquiry is student self-direction in acquiring and using knowledge or skills. The most fundamental reason for teaching the student to learn independently is that, throughout his life, his capabilities of expressing individuality in his choices and actions will be measured by his competencies in self-directed uses of his mind. A second reason for stressing self-direction in the school program is that individualized instruction on a grand scale becomes possible only when the majority of students, most of the time at school, can proceed with their studies without immediate help from their teachers.

There are two distinct ways in which student self-direction can occur within the school program. One involves the use of learning programs that provide the student with sufficient directions that he can proceed without the teacher's help. The second, and educationally the more fundamental, involves the student in planning and conducting his learning activities, that is, in programming his own learning.

A dramatic and important new viewpoint is that all students, not merely "the gifted," can acquire and use competencies in self-directed learning. This is a bold extension of the democratic faith. It is

supported by mounting evidence that nearly all students can learn to guide their learning, and prefer to do so, when assigned tasks are made appropriate and vital.

Theme 4: Individualized Instruction. Individualizing instruction is the most-nearly universal watchword and rallying cry among those who favor innovations in the schools. Programs offering new approaches to individualization are viewed with the most widespread interest. The priority assigned to this theme has several reasons. Child development research has increasingly stressed the magnitude and importance of individual differences. Various new programs have made it appear feasible to adapt instruction to the individual student better than previously. The "new humanism" previously mentioned encourages greater attention to the individual. Also, reactions of intellectuals against automation have favored devoting special attention to enhancing individuality.

The prevailing conception of individualization is that it consists either of independent study or a tutorial relation between the student and his teacher. A more general definition is needed, such as the following: Individualized instruction consists of designing and conducting with each student programs of studies that are tailor-made to fit his learning needs and his characteristics as a learner. Note that this definition requires starting with the individual, not the group, in planning what to teach. Group teaching is not ruled out since it is proper and desirable to assemble and teach students as a group whenever, at the same time, two or more students are ready to study the same task together with group presentation or discussion.

Theme 5: Education for Excellence. The view is gaining currency that instruction with each student should be conducted on the working assumption that he will master what he studies. The traditional view, aided and abetted by psychologists and test-makers, was that the quality of students' performance on any task should range according to the normal distribution curve. The emerging view is that mastery is a feasible standard with all students provided that each student is assigned tasks he is capable of accomplishing, and provided that he is offered the materials, the time, and the help he needs for success. Obviously, employing the mastery criterion throughout the school depends on individualized instruction that permits adapting the learning task, materials and methods, and rate of advancement to the student.

The value bases for employing a mastery criterion universally in education are readily found. John Gardner in Excellence has presented a forceful account of why individual well-being and the general welfare depend on everyone's doing his job well.[18] Bloom has outlined in considerable detail the implications mastery has for the student's progress at school and for his self-concept.[19] Effectively employed, a mastery criterion would largely eliminate the need for remedial instruction. Employed with "slow learners" and "the educationally disadvantaged," it would prepare these millions to achieve much greater effectiveness as workers, citizens, and persons. Employed universally, it would provide that the rank and file of citizens possessed greater competencies for making and implementing responsible decisions in their various life roles. The result should be a much higher probability than now that our citizenry would be able to cope successfully with the problems and challenges of technological society.

Theme 6: Educating Children of Poverty. The crises in the cities and the civil rights movement have given rise to vigorous programs designed to overcome the educational disadvantages suffered by ghetto children, children in poverty areas such as Appalachia and the rural South, and Negro children generally. Representative programs are Head Start, Follow Through, Higher Horizons, and the Job Corps. A conceptual basis for these programs is the working assumption that the educational deficits associated with an unfavorable environment can be removed by instruction that is especially designed to overcome "perceptual deficit," limited vocabulary, and low motivation to learn.

Theme 7: Education for Personal Development. This theme is clearly implied in the writings of many analysts of educational needs for today's world. Francis Chase, for example, gives major attention to this theme in a discussion entitled "The Ends of Education Reconsidered." Thus, he proposes that " ... openness to self, openness to new experience, and autonomy rooted in this dual openness claim a place among the ends of education for reasons of self-fulfilment as well as because they underlie the capacity to make intelligent choices and assume responsibility in situations in which knowledge is incomplete and the consequences of choices are unclear."[20] Chase gives attention also to such aims as choosing one's life purposes, developing a personal style of behavior, and gaining capacities to respond to phenomena and relationships with understanding, appreciation, and appropriate action. Writers also have stressed the importance of developing tolerance for ambiguity, flexibility, and the willingness to take psychic

risks. Recently, increased attention has been given to the development of a positive self-concept, a sense of adequacy and personal worth.

Despite the evident importance of education for personal growth, the school program usually has made few provisions for it. Instruction has been focused predominantly on cognitive learning. The recent publication of a taxonomy of educational goals in "the affective domain" has encouraged educators to give greater attention to the development of attitudes, interests, and values. In the main, however, today's educational reformers are inclined to reason that sound personal growth can best be fostered at school through developing the student's competencies in inquiry and self-direction, and through calling upon him to master his learning tasks. Individualized instruction also is seen as a way of fostering the development of individuality. Indeed, some educators use the term "personalized instruction" to give emphasis to their concern for personal growth at school.

Theme 8: Education for Social Living. This theme, like the preceding one, has received strong emphasis in the analyses made of the education required for living in modern society. It usually has not held a prominent place in the school's curriculum. A reason for expecting it to receive more attention in the near future is the fact that schools in the cities are coming into closer relations with their communities. Steps taken to decentralize the public school system of New York City offer a dramatic example of this trend. Another reason for expecting increased attention to social education is the sharpened concern about racial prejudice and intergroup relations brought about by the civil rights movement.

These eight sorts of educational values by no means exhaust the list of educational aims that have been recommended as important in preparing the student for his world. They do, however, appear to this writer to include the major purposes that have been advanced by educational spokesmen. We turn now to examine how these themes are related to the capacities and uses of educational technology.

Educational Technology and Educational Values

If education were a fully rational enterprise, one would find educators taking the initiative in searching out ways to use new technologies and technological devices to foster, directly or indirectly, the realization of designated educational aims. What usually happens, though, is that the initiative comes from someone representing the new technology who asks how one can put this device, or this methodology, to work in the schools. Frequently the adapter of the technology to education does a good job of relating means to chosen ends, but most often his concern is only directed toward those ends that can most readily be served by the technology at hand. And most often some important educational aims go begging because neither the schoolman nor the technologist has them in mind.

In this examination of relations between technological means and educational ends, we shall consider both what uses are now being made of technology and what further uses lie within the capabilities of the available technologies. It is convenient to organize this means-ends analysis according to the eight themes considered in the previous section, beginning with individualized instruction.

Technology and Individualization. Individualized instruction is the educational aim that today is receiving more attention from both educators and laymen than any other. The chief reason is that a number of advanced programs in individualized instruction are testing the potentialities of recent developments in technology. Many people are optimistic about the practicality of individualization on a grand scale, having seen the progress made in these new programs. Suppes, the director of one of the individualized programs employing an electronic computer, expressed this judgment: "It is not too much to claim that for the first time since public education for everyone became a major goal of our society, individualized instruction at a genuinely deep level is now a feasible goal."[21]

Suppes' judgment may well be correct, even though he realizes that it will be some years before computer-assisted instruction can engage the student in a true dialogue rather than merely offering drill-and-practice, or tutoring, in skills, concepts, and principles. The most important question is not whether some instruction can be tailor-made for the learner, but what instruction can be individualized in this way. To date, individualized programs usually have not gone beyond the skill learnings in reading, spelling, and arithmetic. These learnings are important and individualizing them to the degree already realized is a major achievement.

Programed instruction and computerized instruction appear to have some inherent limitations that will prevent them from being used to individualize education "at a genuinely deep level." True, as Hovland has explained, computer programs can simulate some varieties of thinking.[22]

But Broudy observes that the computer is unable to simulate "molar problem solving" that involves "the recognition of problems, making judgments of relevance, formulating and assaying hypotheses, and choosing some form of commitment. ..."[23] And Chase has noted that no one has been able to program such qualities as "psychic risk-taking," "openness to new learnings," or "deferment of immediate gratification for long-range benefits."[24] Obviously, computers have limitations with respect to learning personal and social qualities. Further, they cannot accommodate a high degree of student self-direction, nor can they teach the student to apply what he has learned in situations away from the computer terminal.

It is probable that the most critical contribution of the computer for individualization will be its uses in the management of learning. Computers have immense capacities for recording, storing, analyzing, and delivering data. Individualized instruction, whereby each student works on tasks that are designed especially for him, demands uses of data in diagnosing, planning, and assessing that far exceed the capacities of the unaided teacher who ordinarily is responsible for 25 or more students at one time. When we learn what data are needed, and how to gather, interpret, and use these data, computerized management systems can permit truly individualized instruction on a massive scale.

Aside from programed instruction and computers, numerous advances in educational technology facilitate individualization through offering the student a greater variety of routes toward gaining knowledge or skills. This means that a student is more apt to find an avenue to learning that is both effective and suited to his "learning style." Audiotapes, videotapes,

film loops, and dial selection systems illustrate such technological resources. Closed-circuit TV, on the other hand, tends to work against individualization since it usually is employed for group teaching.

Technology and Independent Learning. Programed instruction, with or without the use of machines, enables the rank and file of students to proceed with learning tasks on an independent basis and thereby makes individualized instruction feasible. However, programed instruction does not teach competencies in self-direction and succeeds with most students only because it provides very explicit directions for each step in the learning task. The more fundamental basis for independent learning, hence for individualization, is for the student to learn and use competencies in programing his own learning. This requires that he break free from student-proof learning programs. Such programs, however, are of great value in teaching reading and other skills that provide the student access to the knowledge he requires. One problem area with programed instruction is that, while you can lead the student to a learning situation, you can't make him think while he is there. Many students, low on motivation or lacking habits of following directions closely, are not successful with programed instruction.

Technology in Teaching Ideas and Inquiry. There is no question that educational technology can be used effectively to present models of theory and inquiry, and to practice the student in theorizing or in planning, conducting, and assessing certain forms of inquiry. Television has been used to stimulate inquiry and to provide the student with data needed to conduct inquiries. Computer simulation can be employed to individualize

learning of theory and inquiry methods. One of the most imaginative uses of programed instruction is Crutchfield's approach to teaching competencies in productive thinking to children in elementary school. He has developed a sequence of 16 programed booklets, each working out the solution to a mystery. Students working through the booklets on an individual basis are led to participate actively in solving the mysteries through framing their own hypotheses and testing them against the evidence.[25]

Instructional technology involving programed learning obviously has its limitations for teaching theory and inquiry. To think creatively and to behave as an effective inquirer, the student must become independent of programs prepared by others. Of course, it often will happen that a student will need to use a computer or other technological aids in conducting problem-solving tasks.

Achieving Excellence Through Technology. Programed instruction has shown that it is possible for nearly all students to master learning tasks --provided the student has the pre-requisite knowledge and provided the learning program is carefully constructed to lead the student step-by-step through the task while offering knowledge of results immediately after eac step. Such learning programs in the basic skill areas, when they have become fully developed and widely disseminated, can result in a level of literacy much above that yet achieved. They can produce a nation of people who possess the fundamental competencies in language and mathematics that are required for many types of decision making in modern societies. Certainly this is an essential starting point for bringing science and technology under the control of our citizens and for ensuring that technology is used in their interest.

Mastery of basic intellectual skills is only one area of education where excellence is needed. There is the danger that more complex forms of intellectual activity, since they are hard to program and their attainment hard to measure, will not be brought under sufficient instructional control to employ mastery criteria. What is needed is to go beyond present technologies and develop educational counseling to a level where each student is guided toward excellence in the conduct of various sorts of problem solving, and toward achieving personal-social effectiveness in performing his several life roles.

Technology in Educating the Poor. While technology has been accused of dehumanizing education, some of its evidently-human uses have been made in programs for children who come from unfavorable environments. Ghetto children have responded frequently to instruction in reading that employs the "talking typewriter" when other approaches have failed to reach them. Programs of early-childhood education have been designed to establish basic perceptual and cognitive skills that underlie reading and mathematics. "Contingency management" has been employed with ghetto children to reinforce behaviors that help them adjust to school and to learn at school. In short, technology has proven of notable value in gaining educational access to children who were unresponsive to usual instructional approaches. Programed instruction, including that offered via computer, promises also to provide basic education to many millions of youth and adults in our country who otherwise would not have access to such schooling.

Technology in Education for Personal and Social Living. It should occasion no surprise that technology has had little application in the schools toward fostering personal and social growth. The curriculum in elementary and secondary schools, and in colleges likewise, gives little systematic attention to these areas of development. Most educators would say that instructional technology has relatively limited applicability to these educational aims, though they probably would concede that instructional television can be useful in modeling desired personal characteristics and social behaviors.

It was noted earlier that technology as applied in individualizing or "personalizing" instruction, in fostering self-direction and inquiry, and in promoting the mastery of learning tasks, has important implications for personal growth. Recently, academic games such as those described by Coleman have been used in simulating economic, political, and social problems, teaching students singly or in groups to inquire within these areas. The implications of these games for developing social role behaviors and attitudes are evident.[26]

Probably the most significant uses of educational technology in respect to developing personal and social behavior will occur through the uses of computers in educational counseling, following perhaps the approach outlined by Cogswell in which the computer program simulates actual counseling interviews.[27] Another use of computers for this sort of purpose is that of storing, analyzing, and retrieving data that the student's educational counselors can employ in planning, conducting, and assessing

learning activities directed toward personal-social growth. In this type of usage, it is reasonable to expect that computer management can permit effective individualized instruction in an important area that has resisted definition and control within educational programs up to this point.

Summary Assessment on Values and Technology in Education. In perspective, what educational values are being promoted through uses of the new educational technology? The answer must be in terms of directions, trends, and implications since technological developments presently are having only scattered influences on teaching in elementary and secondary schools, and virtually no influences on college teaching.

The most general uses of technology in education concern what Broudy terms "the abatement of ignorance." Programed instruction generally, and computer-assisted instruction particularly, have the potential for achieving universal literacy in our society, reaching people of all ages and circumstances, in and out of school, with individualized instruction that ensures mastery of the basic skills in language and mathematics. Further research-and-development is needed to provide the required methods, materials, and equipment, and massive dissemination approaches are needed to give everyone access to the new instructional programs. The critical point is that technology in the forms of new media and methodologies is making universal literacy within our reach.

Thus far, the uses of technology in education have given only limited attention to developing students' competencies in independent learning and inquiry, or to developing those personal-social qualities

and competencies that characterize the inner-directed yet socially-responsible individual. In other words, the applications of technology in education are mainly directed toward providing everyone with basic intellectual tools without offering instruction in how to use them.

Probably this focus on tools rather than their uses is due to the preference today's educational technologists have shown for the precise control of learning through programed instruction. For this, behavioral objectives--the more specific and concrete, the better--are required. We need other technologists, oriented toward fostering inquiry and personal-social growth, who will give their attention to developing instruction in these directions. Such instruction would include educational guidance and probably would employ computer management of the extensive data required about each student. Also, this instruction probably would use television, films, and computer simulation to present issues, provide data, and model solutions. Its emphasis, as with counseling generally, would be on developing the student's competencies in choosing ends and means, and in acting upon those choices.

Is instructional technology now changing the educational values that are expressed in school programs? The general answer to this question is "No," since technology is focusing on the same learning goals that schools usually have emphasized, that is, concepts and skills.

Thus far, developments in educational technology have given little attention to the humanities, the arts, and the sciences, and instruction in these areas usually is conducted without significant change even in

schools where new technology is being used in teaching reading and mathematics. If today's educational technologists were to move into these other areas, they might try to shift the emphasis more strongly toward teaching concepts and skills in these subjects since they know best how to program these types of goals. The greater probability, however, is that efforts to engineer instruction in an area such as social science will begin with identifying as goals the teaching of theory, inquiry methods, and social attitudes and values. The problem then will be to develop and employ technological approaches that are relevant to these goals. Television, films, academic games, and computer simulation of inquiry about social issues are examples of approaches that already have been applied on occasion to instruction in social science. In sum, we can expect that instructional technology will be addressed to the same types of learning goals that educators long have espoused. The difference will be that technology can greatly improve their accomplishment and make their attainment more nearly universal.

Strategies for Optimizing the Uses of Technology in Education

The technological capabilities are at hand to create a genuine revolution in instruction. To accomplish this, there must be a more effective and better coordinated application of scientific-technological methods together with use of computers and other media. A total "systems approach" is required that begins with decisions about the educational aims that should be pursued, continues with research-and-development procedures for designing, producing, and assessing instructional programs directed

toward the designated aims, and follows through with massive approaches to implementing the innovative programs. Supporting this total approach and coordinated with it must be strategic research in behavioral and social science, projects to engineer applications of new media to education, and programs to enlist public support for the full effort. Since we can assume that this country will not choose to establish a Manhattan Project encompassing all components of the approach, a major determinant of its success must be a high degree of communication among those who are responsible for the various components in order that they can coordinate their efforts.

Research on Educational Values. Usually it is assumed that the aims of education are identified, studied, and justified by educational philosophers, while state departments of education, local school boards, and administrators of school systems decide which educational aims a school system shall pursue. These routes toward determining educational aims are too casual, too unsystematic, to ensure that education will be suited to the needs of individuals and society, today and in the future. Henry Dyer believes that most philosophers have contributed little since World War II to the value question, concentrating instead on "analyzing the absurdity of trying to specify educational goals."[28] Certainly school board members and local school administrators have little expertise in determining relationships between educational aims and individual or societal welfare in today's world.

Marvin Adelson points up the great importance today of making the right decisions about educational aims. He writes: "Many educators agree that education is experiencing a value crisis from which it may emerge as a very different institution. Since it is such a central, formative influence on the character of the society, much of the future of the country and of the world depends upon the outcome."[29] MacLeish quotes Rene Dubos on a similar point: "We must not ask where science and technology are taking us, but rather how we can manage science and technology so that they can help us get where we want to go."[30] John Fritz urges that we must " ... harness the machine and emerging electronic technology to the legitimate aims and tasks of the school ..." and warns of the danger that decision-making and control in education will be assumed by the developers and distributors of new instructional systems.[31]

In a democracy, decisions about the purposes and aims of public schools should be made by the citizens those schools serve. The task for those who are experts on educational values is to offer citizens the data they need for making sound decisions about what the schools should accomplish. Quite recently, as part of the technological thrust within education, policy research has begun to address itself to the study of educational aims in their relationships with the future of man and society. As Willis Harmon indicates, policy research is a technology rooted in systems anal- is and in such approaches as the forecasting of alternative futures. Harmon offers examples of what educational policy research includes: "Analysis of the basic issues involved in the choice of desired outcomes ... Descriptions of feasible alternative future states of education and of

society, and identification of the policy positions which would tend to lead toward each. ... Comparison of alternative means for aiming toward chosen goals. ... Analysis of the basic dynamics of implementation, including studies of anticipated interactions of various groups with different stakes in the policy choice, different perceptions of the problem, different goals, etc."[32] Harmon goes on to offer an analysis of four distinct policy positions respecting educational goals that concern whether motivation to learn is largely extrinsic or intrinsic, and whether the school should focus on cognitive learnings, or on a combination of cognitive and affective learnings.

In Harmon's view, the introduction of modern technology within educational policy making is changing our whole way of thinking about the ends of education. He points out that we are coming to regard "educational outcomes as products to be evaluated" as is the case with industrial production. He says further: "More ambitiously, we are beginning to think in terms of consciously choosing the kind of future we wish to have, and of education as a primary tool for shaping that future."[33]

Policy studies clearly have great potential for showing the relations between various educational outcomes and various individual and societal values. Also, they can contribute by analyzing and assessing how different educational outcomes relate to the concerns of different groups in society. Findings of policy studies, however, cannot be used effectively in educational decision-making until our citizens possess the political education called for by Broudy. Policy research, therefore, must tie in with general public education for using the findings of such research.

Educational Values in the Design of New Instructional Programs.

How effectively are research-and-development methods being employed to build different educational aims into the new instructional programs? Do these programs provide for inquiry, individualized instruction, independent learning, mastery, and personal-social growth? It is this writer's judgment that not one instructional program has yet been designed--either for the elementary, the secondary, or the college level--with the systematic purpose of providing instruction that implements a set of themes such as those listed in the sentence above. When programed instruction is the predominant approach, individualized instruction and mastery are stressed in the teaching of concepts and skills, but there is neglect of inquiry, of competencies in self-direction, and of learning objectives in the personal-social realm. Curriculum projects in natural science, mathematics, and social science tend to emphasize the teaching of theory and inquiry, but do not provide for individualization, self-direction, or mastery. New plans for organizing schools, notably nongraded programs and team teaching, offer only unsystematic provisions for individualization, independent learning, and inquiry. Computerized scheduling programs tend to be quite neutral with respect to any educational aims.

The best that one can say about the design of new instructional programs is that, when they are systematic, this quality applies to one or more sub-systems within the total program. Perhaps this is all one can reasonably expect at this early stage of applying research-and-development strategies, or the systems approach, to education. In any event, the new

educational technologies--methodologies and media--have only begun to find application toward realizing in instruction a full set of educational values.

Educational Values and Technology in the Education of Educators. Probably nowhere in the educational reform movement have educational values received so little attention as in the new programs of teacher education. There are signs that this situation will shortly begin to change; but, during the past decade, beginning with the Master of Arts in Teaching (MAT) and continuing through interaction analysis and micro-teaching, it has been as though the designers of these programs had no awareness of the educational aims characterizing today's efforts to transform instruction. With almost no exceptions up to the last year or two, the new teacher education programs have been employing the new methods and media to train teachers to teach in conventional instructional programs directed toward conventional educational goals. Micro-teaching, for example, has been using video-taping to assist in training teachers to conduct whole-class instruction via lecture and discussion. The training has ignored individualization, self-direction, mastery, and inquiry. Interaction analysis has been used to train teachers to analyze whole-class teaching with no attention to the educational values involved aside from such matters as the amount of teacher-talk or pupil-talk, or the methods the teacher used to encourage or discourage different sorts of pupil participation in whole-class discussion.

Technology in the schools will have profound effects on teachers' roles, hence on teacher education. One possibility receiving attention is that the teacher can be by-passed through computerizing the planning, conduct, and assessment of instruction. This means that the instructional program would become both "teacher-proof" and "student-proof" in the sense that neither teacher nor student, despite inadequacies, could derail instruction. This would amount to what Alvin Weinberg has termed a "Quick Technological Fix," that is, solving an essentially-educational problem by fool-proofing the machine.[34] An illustration of the Technological Fix is to increase highway safety through making cars more-nearly fool-proof rather than through improving the selection, training, and control of drivers. The sensible answer to this man-machine dilemma seems obvious: for increased traffic safety, improve both cars and drivers; for better instruction, strengthen both the school's instructional program and the competencies of its staff.

During the past couple of years, some experimental teacher education programs that focus on training teachers to individualize or personalize instruction have been initiated at a number of institutions including Bucknell University, Brigham Young University, University of Texas, and Research for Better Schools in Philadelphia. We have yet to see teacher education programs that offer systematic preparation for teaching competencies in self-instruction or inquiry, though some experimental programs--at the University of Chicago and Carnegie-Mellon University, for example--are exploring this area.

A systems approach to teacher education would require that teachers (or "instructional managers") receive formal training in specifying different sorts of educational goals within the areas they teach in measuring the attainment of those goals, in planning and conducting lessons directed toward those goals, and in managing individualized instruction. In short, teachers require training in operationizing educational values through the conduct of the instruction they offer their students. Until teachers have such training, the set of educational values under consideration in this paper has little chance of governing instruction in the schools.

What has been said about the education of teachers applies also to the education of school administrators and supervisors, of education professors, and of specialists in educational technology. For the educational system to work in terms of a given set of educational values, all essential components of the system, personnel as well as materials and media, must contribute in coordinated ways toward the attainment of those values.

Educational Values, Media, and Public Education. From the foregoing analysis, it appears that one critical need is for the attention of systems technologists, policy researchers, and other specialists to turn toward developing ways to educate the public on ends and means in education. How, for example, can the thinking citizen learn the whys and hows of individualized instruction? How can he learn the nature and importance of problem-solving thinking (inquiry) as an educational aim? How can he come to learn the reasons for teaching every student competencies in

independent learning? The need is for broad public education that provides a conceptual grasp of educational aims and of ways to attain them. This is what the citizen should have as a basis for decision-making in relation to his own education, that of his children, and that of his neighbors.

Various approaches to public education of this sort can be devised and tested by educational technologists. Giving members of the community a greater role in planning and conducting the school's program is one possibility. Conducting orientation programs for parents and other community members at school during evenings is another way. But the approach that appears most promising is to offer television courses on educational values that are designed to interest and inform the public. The challenge for program designers is to find an instructional approach that will capture the imagination and fancy of television audiences, not to amuse but to stimulate, to concern, and to teach. Probably the entertainment models for TV programs would not work for this purpose. The problem is that of being honestly didactic yet compelling and gratifying, and this on a massive basis. Is the technology of TV programing sufficiently advanced that it can develop serious educational programs that will capture and hold today's audiences? If the Public Broadcasting Act can help achieve public literacy on educational ends and means, it will have performed a high service in the national interest.

FOOTNOTES

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